

Claim 1 recites a robotic arm structure including at least two links and an end effector attached to a distalmost link and being rotatable about an end effector axis. A motor is connected to rotate the end effector about the end effector axis to thereby provide a yaw motion of the end effector. Means are provided for monitoring and controlling the yaw motion such that the end effector axis can be moved in a straight line which is not restricted to the radial direction. Claim 1 has been amended by incorporating dependent Claim 50 and recites that the end effector moves in a straight line and maintains a constant orientation of the end effector.

The ability of the end effector to be moved in a straight line which is not restricted to the radial direction while maintaining a prescribed orientation provides a distinct advantage over the prior art. In particular, the prior art substrate processing systems were limited to either 1) processing stations arranged in a row and loaded by a robot which travels on a track parallel to the row of processing stations, or 2) processing stations arranged in a circle around a rotating robot. These arrangement limitations were due to the fact that the end effectors or end effector axes of the robots were all designed to move forward and backward along a path which extends radially from a central axis of the robot arm and the rotation of the end effector was linked to the motion of the arm. Moving the end effector in a straight line is particularly important when moving substrates into and out of cassettes and processing stations in order to guarantee proper insertion and removal.

As stated in the Office Action, FIG. 14 of Ueyama, et. al. discloses an end effector which is offset from an end effector axis and moves in a non-radial straight line. However, the non-radial straight line of travel of the Ueyama, et al. end effector is limited to a line which is displaced from the radial direction by a fixed amount and clearly does not have the versatility of the present invention because the end effector is not independently driven. The device of Ueyama, et al. is generally the same as conventional two link robot arms except that the end effector is shifted to the left or right some distance D from the end effector axis. This is the only straight line that the end effector can move along. For example, if D is nonzero then the end effector cannot move in a straight line which goes



through the center of the robot. This does not eliminate the major restrictions of these robots.

Amended Claim 1 recites that the end effector axis can be moved in a straight line which is not restricted to the radial direction while maintaining an orientation of the end effector. This is not possible with the arm of Ueyama, et. al. The task of moving a rigid body (end-effector) in a plane while maintaining its orientation requires three degrees of freedom - two degrees of freedom to move the characteristic point of the body in a specific path (straight-line, etc.) and one degree of freedom to maintain its orientation. Usually, when the end effector moves in a straight line the end effector orientation is kept collinear with the straight line. When moving in a more complex trajectory (2nd, 3rd order curves) the end effector is typically required to be parallel to the current tangent to the curve or to have a fixed orientation with respect to the coordinate frame adjacent to the curve. The invention of Ueyama, et al. has two degrees of freedom and therefore can not solve any task related to maintaining end-effector orientation.

Tabata, et. al. describes a robot having a distal end which can be moved in a straight line to reach a desired position in a minimum time. However, Tabata, et al. does not address the control of an end effector and especially the end effector orientation. If a conventional end effector is placed on the robot of Tabata, et. al. this end effector will not have the requisite controls to allow the end effector to move in a straight line which is not restricted to the radial direction and to maintain a consistent orientation of the end effector.

Any combination of Tabata, et. al. and Ueyama, et. al. does not teach or suggest a robotic arm structure as described in amended Claim 1. In particular, the prior art does not disclose an end effector having an axis which can be moved in a straight line which is not restricted to the radial direction, while an orientation of the end effector is maintained constant. The addition of an independently driven end effector to existing robot structures in accordance with the claimed invention creates an entirely new robotic structure with motion capabilities and advantages that cannot be achieved by the existing prior art or


combinations thereof. Accordingly, Claims 1 and Claims 2-7, and 49 depending from Claim 1, are allowable over the combination of Tabata, et. al. and Ueyama, et. al.

Claims 4, 6, and 7 have been rejected under 35 U.S.C. §103 as being unpatentable over Tabata, et al. in view of Ueyama, et al. and further in view of Nishida, et al. In addition, Claim 5 has been rejected under 35 U.S.C. §103 as being unpatentable over Tabata, et al. in view of Ueyama, et al. and further in view of Tateyama, et al. Claims 4-7 are allowable for at least the same reasons discussed above with respect to Claim 1.

Claims 31, 35, 39, 46 and 47 have been rejected under 35 U.S.C. §103 as being unpatentable over Tabata, et al. in view of Ueyama, et al. and Corwin, Jr., et al. Claims 44 and 48 have been indicated to be allowable over the prior art. Accordingly, independent Claims 31 and 39 have been amended to incorporate the subject matter of allowed Claims 44 and 48. In addition, Claim 45 has been amended to incorporate the allowable subject matter of Claims 44 and 48 by reciting an end effector having at least two hands.

Reconsideration and allowance of the above-identified application are respectfully requested. In the event that there are any questions concerning this amendment, or the application in general, the Examiner is respectfully urged to telephone the undersigned attorney so that prosecution may be expedited.

Respectfully submitted,
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